MSC Guidelines for Review of Oil-Fired Main Boilers

Procedure Number: E2-22 **Revision Date: 04/28/99**

References

a. Title 46 CFR Parts 58, 61 and 62

b. Title 46 CFR Parts 111 and 112

c. Navigation and Inspection Circular (NVIC) 2-89, "Guide for Electrical Installations on Merchant Vessels and Mobile Offshore Drilling Units"

d. Navigation and Inspection Circular (NVIC) 8-84, "Recommendations for the Submittal of Merchant Marine Plans and Specifications"

e. American Bureau of Shipping (ABS), "Rules for Building and Classing Vessels"

f. Safety Of Life at Sea (SOLAS), Consolidated Editions, 1997, Chapter II-1, Parts D and E

g. Work Instructions E2-1, E2-5, E2-17, E2-18, and E1-12.

Disclaimer

These guidelines were developed by the Marine Safety Center staff as an aid in the preparation and review of vessel plans and submissions. They were developed to supplement existing guidance. They are not intended to substitute or replace laws, regulations, or other official Coast Guard policy documents. The responsibility to demonstrate compliance with all applicable laws and regulations still rests with the plan submitter. The Coast Guard and the U. S. Department of Transportation expressly disclaim liability resulting from the use of this document.

Contact Information

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General Review Guidance

The following information should be provided to assist with timely and accurate plan review:

- Manning level of the engineering department (fully-manned, minimally attended (MAMS), or periodically unattended (PUMS) machinery spaces).

- Scope of the vital system automation submittal, with sufficient throughness in all submitted documents and adherence with the submittal guidelines of NVIC 8-84
- A designated single point of contact or with direct contact information
- The configuration of the steam plant, i.e., location of main boiler(s), main boiler control console (if any), steam engines, maneuvering platform, and main boiler auxiliaries.
- Clearly identify equipment or systems that are automated or remotely controlled.

Required Plan Submittals

- A qualitative failure analysis (QFA) of the following (see MSC procedure **E2-18):**

  a. Control systems that are microprocessor or computer-based.
  b. Safety controls.
  c. Alarm systems that is microprocessor or computer-based.

- Design verification test procedures (DVTP) for each of the failures considered in the QFA (see MSC procedure **E2-05).**
- Boiler Alarm Systems (see MSC procedure **E2-01).**
- Fluid Power and Control Systems (see MSC procedure **E2-12).**
- Periodic Safety Test Procedures (PSTP(see MSC procedure **E2-17).**
- Console drawings and internal component layouts of the remote control or automatic control system.
- Manufacturer or designer's certification of the automated control system.
- Sources of power of the control system.
- Compliance with the regulations may be verified using the logic or schematic diagram of the control systems.

- Note: the following items marked "(**TP**)" should have step-by-step instructions for functional testing for inclusion in the PSTP document.

Main Boiler

- Required Safety Trip Controls regardless of intended mode of operation (46 CFR 62.35-20(a)(1)): (**TP**)

  Burner Trip
  a. Loss of burner flame
  b. When actuated by the boiler safety trip control system

  Boiler Trip
  a. Boiler low-low water level
  b. Inadequate boiler air flow to support complete combustion
  c. Loss of boiler control power
  d. Manual safety trip operation
  e. Loss of flame at all burners

- Manual Alternate Control should be located at the boiler front. 46 CFR 62.35-20(a)(2) (**TP**)

- Minimum controls or systems of a fully automatic main boiler: 46 CFR 62.35-20(a)(3)

  a. Automatic combustion control
  b. Programming control
  c. Automatic feedwater control
  d. Safety controls
  e. An alarm system

- After system line-up and starting of auxiliaries, fully automatic main boilers should only require the operator to initiate the following sequences (46 CFR 62.35-20(a)(4)): (**TP**)

  a. Boiler prepurge
  b. Trial for ignition of burners subsequent to successful initial burner light-off
  c. Normal shutdown
  d. Manual safety trip control operation
  e. Adjustment of primary control setpoints

Boiler Control Loops

- Boiler Control Loops

a. Feedwater Control. Automatic feedwater control loop should sense at a minimum the boiler water level and steam flow. 46 CFR 62.35-20(b)

b. Combustion Control. The control loop should provide a low fire interlock to prevent high firing rates and superheater damage during boiler warm up. 46 CFR 62.35-20(c) (**TP**)

c. Programming Control. Control should provide a programmed sequence of interlocks to provide the safe ignition and normal shutdown of the boiler burners. Control should prevent ignition if unsafe conditions exist and should include the following minimum sequence of events and interlocks (46 CFR 62.35-20(d)): (**TP**)

(i) Prepurge. 46 CFR 62.35-20(d)(1)

(1) Boilers should undergo continuous purge of the combustion chamber and convecting spaces for a minimum of 5 air changes.
(2) The purge should not be less than 15 seconds in duration. (**TP**)
(3) Purge should occur immediately prior to the trial for ignition of the initial burner of a boiler. (**TP**)
(4) All registers and dampers should be open. (**TP**)
(5) Air flow of at least 25 percent of the full load volumetric air flow should be proven before the purge period commences.
(6) Prepurge should be complete before trial for ignition of the initial burner. (A prepurge is not required immediately after a complete post-purge.) (**TP**).

(ii) Trial for ignition. 46 CFR 62.35-20(d)(2)

(1) Only one burner per boiler should be in trial for ignition at any time. (**TP**)
(2) Total air flow during light off should be sufficient to prevent pocketing and explosive accumulations of combustion gases.
(3) The burner igniter should be in position and proven energized before admission of fuel to the boiler. (**TP**)

(4) The igniter should remain energized until the burner flame is established and stable, or until the trial for ignition period ends.
(5) The trial for ignition should be a short as practical for the installation, but should not exceed 15 seconds. (**TP**)
(6) Failure of the burner to ignite during the trial for ignition should automatically actuate the burner safety trip controls (**TP**).

(iii) Post-purge. 46 CFR 62.35-20(d)(3)

(1) Immediately after normal shutdown of the boiler, an automatic purge of the boiler equal to the volume and duration of the prepurge should occur. (**TP**)
(2) Following a boiler safety trip control operation, the air flow to the boiler should not automatically increase. Post purge in this case or if determined necessary, should be under manual control. (**TP**)

(d) Burner Safety Trip Control System. 46 CFR 62.35-20(h)

(i) A flame detector is required for each burner.
(ii) The burner fuel oil valve should automatically close when:

(1) Loss of flame to the burner (**TP**)
(2) Burner valve is not properly seated (**TP**)
(3) Trial for ignition fails, if a programming control is provided (**TP**)
(4) Actuated by the boiler safety trip control system (**TP**)

(e) Boiler Safety Trip Control System. The control system should automatically close the master and all burner fuel oil valves in the event of the following (46 CFR 62.35-20(i)):

(i) Boiler low-low water level. Sensor or control must account for normal vessel motions and operating transients (**TP**)
(ii) Inadequate air flow to support complete combustion (**TP**)
(iii) Loss of boiler control power (**TP**)
(iv) Actuation of the manual safety trip control (**TP**)
(v) Loss of flame at all burners (**TP**)

Other Items

- Permissives Programming control and safety control systems requirements should be met when a boiler (46 CFR 62.35-20(a)(5)):

  a. Automatically sequences burners
  b. Is operated from a location remote from a boiler front (**TP**)
  c. Is fully automatic

- Combustion Control Loop. The automatic control loop should provide the following (46 CFR 62.35-20(c)):

  a. An air/fuel ratio which ensures complete combustion and stable flame with the fuel in use, under light-off, steady state, and transient conditions.
  b. Stable boiler steam pressure and outlet temperatures under steady state and transient load conditions.

- Burner Fuel Oil Valves. 46 CFR 62.35-20(e)

  a. A burner fuel oil valve for each burner should be provided.
  b. The operation of the burner or boiler trip control should automatically close the burner valve.
  c. Opening or closing should be operated by the programming control or combustion control loops.

- Master Fuel Oil Valves. Each boiler should have a master fuel oil valve to stop fuel to the boiler automatically when the boiler safety trip control system operates. 46 CFR 62.35-20(f) (**TP**)

- Where light oil pilots are used, the following must be met (46 CFR 62.35-20(a)(6)):

  a. programming control and burner safety trip controls must be provided for the light oil system,
  b. trial for ignition must not exceed 15 seconds, and
  c. the main burner trial for ignition must not proceed until the pilot flame is proven

- Valve closure time for the burner and master fuel oil valves must be within 4 seconds of automatic detection of unsafe trip conditions. 46 CFR 62.35-20(g).

- Main Boiler Auxiliaries

  a. Auxiliary machinery vital to the main propulsion system must be provided in duplicate, unless the system served is provided in independent duplicate, or otherwise provides continued or restored propulsion capability in the event of a failure or malfunction of any single auxiliary component. 46 CFR 58.01-35.
  b. For minimally attended machinery plant operation, the ECC must include controls to place main boiler vital auxiliaries in operation (unless automatic transfer is provided), and to shutdown such equipment when necessary. 46 CFR 62.50-20(a)(4). (**TP**)
  c. For periodically unattended machinery plant operation, redundant main boiler auxiliaries must automatically transfer to the backup units upon failure of the operating units. 46 CFR 62.50-30(b). (**TP**)

- Control System Power Supply 46 CFR 62.30-5(c) (**TP**)

  a. Two sources of power required for the main boiler primary (automatic) and safety controls.
  b. Failure of the normal source of supply must actuate an alarm in the machinery spaces.
  c. One source of supply must be supplied from the emergency power source.

- Machinery Stop Stations 46 CFR 111.103-9 and 58.01-25. (**TP**)

  a. Required for forced-draft and induced-draft fans, fuel oil pumps and similar fuel oil pumps.
  b. Located in a readily accessible position outside the space.
  c. Controls suitably marked and protected against accidental operation and tampering.
  d. Controls must be arranged so that damage to the switch or cable automatically stops the equipment controlled.
  e. For periodically unattended machinery plant operation, these controls must be included in the fire control station required in 46 CFR 62.50-30(h).

Attachments

None.